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Paper Tape Conversion Procedures*

by

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ABSTRACT

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Programs have been implemented for the conversion of punched paper tape information to IBM 7090/94 compatible card image records on magnetic tape, punched cards and printed page. The data is input by an IBM 1011 Paper Tape Reader or an IBM 1012 Paper Tape Punch to an IBM 1401 processor which performs selective output operations according to user provided format control cards. Two types of programs have been made available, one for constant length paper tape records and one for records of varying length. The former program generates execution time instructions resulting from the user specifications whereas the latter uses a fixed stored program, branching at option test points.

Author

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1. Introduction

Recent advances in scientific instrumentation have resulted in an abundance of digital data output from experiments in the physical and natural sciences. Most common among the output devices are paper tape punches. Computer research involving natural language text frequency requires input character sets expanded over those of keypunches. Again, punched paper tape provides input flexibility and low production cost. The use of such data in most high speed computers, however, necessitates its conversion to a form more amenable to such devices.

The program described here, available at the University of Maryland Computer Science Center, perform such conversion to magnetic tape, punched cards and printed page using an IBM 1401 computer and either an IBM 1011 Paper Tape Reader or an IBM 1012 Paper Tape Punch as the input device.

The IBM 1011 Paper Tape Reader accepts as input either 5 or 8 channel paper tape. There are 31 permissible punch configurations for the 5 channel tape (2 of which have assigned functions) and 65 for the 8 channel tape. These are displayed in appendices A and B. Any of those configurations may be input to and output by the IBM 1401 as any one of the 64 1401 characters exclusive of the group mark (CBA8421 bits) by means of proper control panel wiring. The particulars of control panel wiring are reviewed in IBM Systems Reference Manual Form A26-5754-0, IBM 1011 Paper Tape Reader. Standard control panels will be made available, following the conventions of appendices A and B. The user must supply his own wired panel if he wishes any modification or additions in the interpretation scheme.

The IBM 1012 Paper Tape Punch has the additional capability of reading all 256 possible punch configurations on the 8 channel paper tape. Any of those configurations may be input to the 1401 and internally decoded to any one of the 64 1401 characters exclusive of the group mark (CBA8421 bits) by setting up a decoding table according to the rules explained in appendix C. A standard table will normally be provided, again following the conventions of appendices A and B.

In order to properly use the programs described here, one of the permissible punch configurations must be reserved as the "end of record" (EOR) character. This character serves only to define an input record length. Sensing the EOR character temporarily terminates the paper tape read operation and initiates the selective output operation. There should be no more than 4000 input characters between EOR's due to computer storage limitations.

Output from the programs after conversion of the paper tape data may be produced on magnetic tape, punched cards, and the printed page depending upon the setting of sense switch options. The form of the output, as opposed to the medium of the output, is controlled by user control cards. These are explained under the individual program descriptions.

The two programs available distinguish between the two basic forms of the input data. Program I assumes all the paper tape data input records to be of the same length, known by the user. This permits the user to completely specify the arrangement of the output record or records corresponding to one input record. Each successive input record will produce one or more output records according to the user specifications. Program II is designed to deal with variable length input records, similar to those encountered in natural language text. The output here may be in either a blocked or continuous format.

In addition to the detailed description of program options and restrictions, a discussion of the techniques used in the conversion programs is also presented in the hope that it will aid in the solution of similar problems.

2. Program I - Constant Length Paper Tape Records

The input to this program must be constant length paper tape records of less than 4000 characters each. The format of the output for each record is specified by the user on his control cards and the output medium is controlled by selected sense switch settings.

Sense Switch A - Card Reader Control

Switch A must always be up.

Sense Switch B - Magnetic Tape Conversion

With Switch B UP, 84 character card image records resulting from the conversion of the paper tape records will be output on magnetic tape unit 1. Only the contents of the first 80 columns of each card image may be specified by the user, the last 4 columns will always be blank. This output provides complete 7090/94, 800 BPI, BCD compatibility. When reading the magnetic tape back with a 7090/94 program the user may treat the data as if he were reading from punched data cards submitted with his program deck but placed on a separate input tape.

If more than one magnetic tape is required for the resulting output, a message will be printed on-line indicating how many card image records were output on the tape that ran out. One end of file indicator will be written on this tape and instructions will be given to load a new tape. The last tape will be terminated by writing four end of files.

Sense Switch C - Punched Card Conversion

To elect punched card output according to the specified format, Sense Switch C must be UP. The output data will be preceded by an identification card.

Sense Switch D - Printed Output Conversion

Sense Switch D UP requests the printing of the resulting 80 character card images at 60 lines per page. The primary purpose of such output is to monitor the information being output onto magnetic tape.

Sense Switch E - Parity Error Control

To terminate the program upon encountering a parity check, Switch E should be UP. All of the 65 permissible paper tape punch configurations have an odd number of punchings. This serves as a parity check on the input data. If a hole is mispunched resulting in an even number of punches or if the paper tape reader malfunctions in its interpretation of a punch configuration, a parity error check may be sensed by the program.

With Switch E DOWN, a message will be printed on line indicating that parity error has occurred, and the program will proceed as if normal. If the latter option is desired, one may elect a character to replace the one in error via means of control panel wiring (see IBM Reference Manual, Form A26-5754-0, IBM 1011 Paper Tape Reader). Parity checking does not exist on programs using the IBM 1012 Paper Tape Punch as the input device.

Sense Switch F - Paper Tape Reel Count

If more than one reel of paper tape is to be read and output as if it were a continuation of the previous reel, Switch F should be up. If only one reel of tape is to be read, the switch should be DOWN.

Sense Switch G - Invalid

The setting of Switch G will have no effect on this program.

Identification Card

The first card placed after the 1401 program deck must be the standard UOM \$ID card. None of the options will be recognized but the user's name and number must be given.

Format Cards

If one visualizes the characters of the input paper tape record as being numbered consecutively from 1 through the number of characters before the EOR indicator, the format of the output on successive 80 column card images may be simply specified on the format cards which directly follow the identification card.

The two basic formatting instruction codes are C (for characters) and S (for spaces).

C The C represents character numbers. It must be followed by either a number or a number followed by a hyphen followed by a numerically greater number. It indicates which characters from the input record are to be output. Character groups or portions thereof may be repeated in the same output record.

S The S represents blank spaces in the output record. It must be followed by a single number representing the number of blanks requested between the character groups output by the C control character. The output record, though split into 80 character card images, is to be considered one continuous record. Thus, designating 20 spaces to appear after 75 characters have been output on the output record will result in columns 76 through 80 of the first card image and 1 through 15 of the second card image of the output record to be blank.

Control specifications should be separated by commas. All blanks on the control cards will be ignored. There may be any number of control cards.

Example 1:

Format control card 1:

C1-20, S6, C 21 - 40, S6, C41-60, S 7,

Format control card 2:

C 141, C 101-120, S6, C 121 - 140, S33, C141

This results in the following output for each input record:

[illegible]

After outputting characters 1 to 20, six spaces are skipped. Characters 21 to 40 and 41 to 60 are output on the same card, the groups being separated by six spaces. Character 141 is then output in column 80 of card image 1. On card image 2, characters 101 to 120 and 121 to 140 are similarly placed, as is character 141 again in column 80 of card image 2. Note that input characters 61 through 100 were entirely ignored and that the character group consisting of character 141 only was repeated on both card images of the output record.

Example 2:

Format control card 1:
C 1 - 1550

This results in the production of 20 output card images for the 1550 characters of the input record. Each of the first 19 card images will contain 80 columns of information, the last card will contain the last 30 characters in columns 1-30 and will be filled with 50 trailing blanks.

Conversion Procedure

The format control cards are scanned for the control identifiers C or S. Recognition results in the conversion of the accompanying numeric fields to machine addresses. Instructions to move the specified input data characters to the specified output record positions are then generated using the converted addresses, now relocated to the beginning of the input and output buffers. Whenever 80 card image columns have been filled, a branch instruction to the output subroutine is generated. The generated instructions are placed starting at the beginning of the 4000 character input buffer and a corresponding increase in the address of the input buffer is made. In so sharing the input area, the restrictions on the maximum number of output specifications and/or the number of input characters per record are minimized. Once the instructions are generated, the program loops between three basic program sections which input, selectively move, and output the data.

3. Program II - Variable Length Paper Tape Records

The input to this program may be paper tape records of varying length, each less than 4000 characters. The output from successive input records may be in either blocked or continuous form. The former fills successive output records with the contents of the input record, filling out the last output record with trailing blanks. The continuous format option outputs records without adding blanks to complete the record; the input records continue on the incompleated output record. The card image output records may be filled with either 72 or 80 columns of input characters, depending upon the user sense switch options.

Sense Switch A - Card Reader Control

(See explanation under Program I description)

Sense Switch B - Magnetic Tape Conversion

(See explanation under Program I description)

Sense Switch C - Punched Card Conversion

(See explanation under Program I description)

Sense Switch D - Printed Output Conversion

(See explanation under Program I description)

Sense Switch E - Parity Error Control

(See explanation under Program I description)

Sense Switch F - Paper Tape Reel Count

(See explanation under Program I description)

Sense Switch G - Column Count Control

With Switch G UP, 80 columns of each output card image will be filled with the input information. If Switch G is DOWN, only 72 columns of each card image will be filled,

the remaining columns being blank.

Identification Card

The first card placed after the 1401 program deck must be the standard UOM \$ID card. None of the options will be recognized, but the user's name and number must be given.

Format Card

The word "CONTINUOUS" or "BLOCKED" should appear anywhere on the first control card following the \$ID card, depending on the output option desired by the user. No other control cards are valid.

Conversion Procedure

Characters are moved from the input buffer to the output area one at a time after a check is made for the group mark in core storage entered at the end of the input record. A branch to the output subroutine is made whenever 72 or 80 characters have been transferred to the output buffer, depending upon the user column number option. An additional transfer to the output subroutine may be made upon encountering the group mark in core storage, again depending upon the user's selection of the BLOCKED or CONTINUOUS output option.

Appendix A - Standard Decoding Scheme for 5 Channel Telegraphic

Paper Tape

Tape punchings	Letters Shift		Figures Shift	
	Decode exit	Encoded hub char.	Decode exit	Encoded hub char.
54f321				
00.	A	A	F-A *	
0 . 00	B	B	F-B	
0.00	C	C	F-C	
0 . 0	D	D	F-D	
0 .	E	E	3	3
0 .00	F	F	F-F	
0. 00	G	G	F-G	
.0 0	H	H	F-H	
0.0	I	I	8	8
00. 0	J	J	F-J	
00.00	K	K	F-K	
0. 0	L	L	F-L	
.000	M	M	F-M	
.00	N	N	F-N	
. 00	O	O	9	9
0.0 0	P	P	0	0
00.0 0	Q	Q	1	1
0. 0	R	R	4	4
0 .0	S	S	F-S	
. 0	T	T	5	5
00.0	U	U	7	7
0.000	V	V	F-V	
00. 0	W	W	2	2
0 .000	X	X	F-X	
0 .0 0	Y	Y	6	6
0 . 0	Z	Z	F-Z	
.0	SP	Space	SP	Space
. 0	CR	Carr.return	CR	Carr.return
0.	LF	Line feed	LF	Line feed
00.000 †	LTR	Letter shift	LTR	Letter shift
00. 00 †	FIG	Figure shift	FIG	Figure shift
.	NC	No code	NC	No code

* F- characters are unwired; they are encoded as spaces.

† This punch configuration is permanently assigned to this function.

Appendix B - Standard Decoding Scheme for 8 Channel Paper Tape

<u>Tape punchings</u>	<u>Decode exit hub</u>	<u>Encoded char.</u>	<u>Tape punchings</u>	<u>Decode exit hub</u>	<u>Encoded char.</u>
EX08f421			EX08f421		
o .	0	0	oo .ooo	X	X
. o	1	1	ooo.	Y	Y
. o	2	2	o o. o	Z	Z
o . oo	3	3	o .	-	-
.o	4	4	oo . o	/	/
o .o o	5	5	ooo .	&	+
o .oo	6	6	ooo. oo	,	,
.ooo	7	7	oo o. oo	.	' apos.
o.	8	8	oo.o	@	(
oo. o	9	9	o o.o	%	*
oo . o	A	A	o o.o	*)
oo . o	B	B	oooo.o	#	=
ooo . oo	C	C	o. oo	\$	u.c. †
oo .o	D	D	o oo. oo	TF	omitted
ooo .o o	E	E	oooo.ooo	EOL	GroupMark(EOR)
ooo .oo	F	F	o .	SKIP	u.c.
oo .ooo	G	G	ooo.oo	CORR	u.c.
oo o.	H	H	oo.ooo	ERR	u.c.
oooo. o	I	I	o o.ooo	CR	u.c.
o o. o	J	J	o oo.oo	SP	Space
o o . o	K	K	o .	PI 1	u.c.
o . oo	L	L	oo. o	PI 2	u.c.
o o .o	M	M	o o. o	PI 3	u.c.
o .o o	N	N	o o. o	PI 4	u.c.
o .oo	O	O	ooo.o o	PI 5	u.c.
o o .ooo	P	P	oo o.o o	PI 6	u.c.
o oo.	Q	Q	o oo.o o	PI 7	u.c.
o o. o	R	R	o.o o	EC1	u.c.
oo . o	S	S	o.oo	EC2	u.c.
o . oo	T	T	o o.ooo	SP1	u.c.
oo .o	U	U	oooo. o	SP2	u.c.
o .o o	V	V	oo o.oo		
o .oo	W	W			

† u.c. characters are unwired; they are encoded as spaces.

Appendix C - Decoding Tables for IBM 1012 Input

If other than the standard decoding scheme displayed in appendices A and B is desired when the 1012 Paper Tape Punch is used as the input device, a decoding table must be typed and the program in question, reassembled.

8 Channel Paper Tape Decoding

The 8 track tape punching to three character address translation scheme appears in figure 1. Each punch configuration produces a unique three digit table address. Columns 3 through 5 of the blank decoding table cards that will be provided upon request, will contain the relative table addresses, and column 24 will contain the 1401 character, to which the paper tape punchings are to correspond.

The card containing the relative address of the punch configuration chosen as the EOL character, must have rows 12, 7 and 8 of column 24 punched.

The program will ignore the paper tape punch configuration with all tracks, except the EOL track, punched. This provides a character delete code for error correction. The feature may be altered only by reprogramming.

All unspecified punch configurations will produce spaces in the output. None of the 378 decoding table cards may be deleted from the deck.

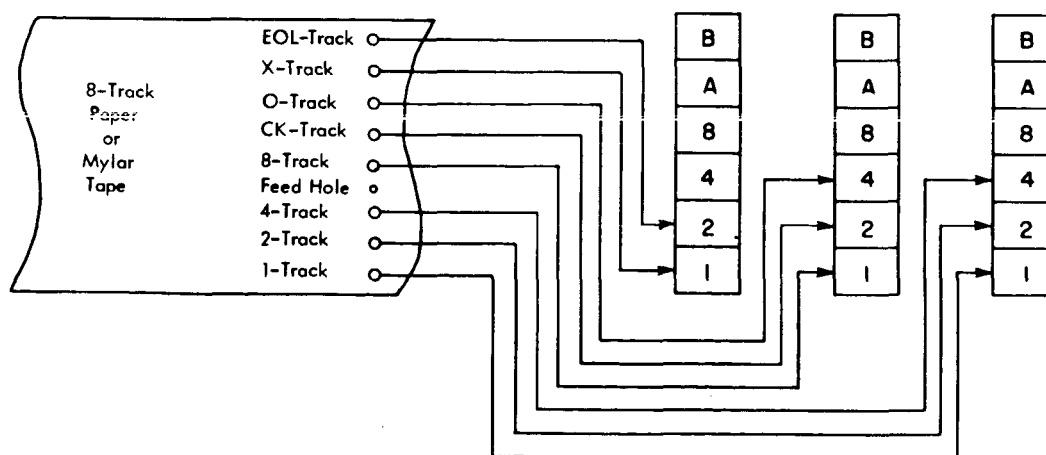


Figure 1. 8 Track Tape Punching to Relative Table Address Translation

Example: Assign the tape punching of tracks 1-0-X to be output as the character A.

Following the arrows of figure 1, tracks 1-0-X correspond to relative table address 141. Punch an A in column 24 of the decoding table card with 141 in columns 1 through 3, to produce the card illustrated below.

PAGE LINE COUNT			LABEL		OPERATION		(A) OPERAND		(B) OPERAND		LOADING CODE		ASSEMBLED INSTRUCTIONS		IDENTIFICATION	
25	141	01	DCL		A											
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

5 Channel Paper Tape Decoding

The 5 track tape punching to three character address translation scheme appears in figure 2. As with normal plug board operation on the IBM 1011, the 5 channel program for the IBM 1012 interprets the punch configurations occurring after encountering a letter shift code (paper tape track numbers 1-2-3-4-5) in the tape, differently than after encountering a figure shift code (paper tape track numbers 1-2-4-5). The character shift codes themselves, cause no character entry into core storage. The decoding table, however, may be arranged to decode the same punchings occurring before and after a mode shift in the same way.

When typing the decoding table cards for 5 channel interpretation, all figure shift character cards will have a 1 punched in column 3 and all letter shift character cards will have a 0 in column 3. Columns 4 and 5 will contain the last two digits of the relative address corresponding to the tape punching configuration. Except for this adjustment, the decoding table cards should be prepared as for 8 channel interpretation. There are, however, only 76 table cards for 5 channel decoding.

The program will ignore the paper tape punch configuration with track 4 only punched. This provides a line feed character for leader and trailer on the tape. This feature may be altered only by reprogramming.

Expanded Interpretation

The current programs allow for only one character output for each input configuration. This limits interpretation to only 64 unique characters. The programs were so constructed, however, so that they may be simply modified to output two or three characters corresponding to each input character. All that need be altered is the character count in the decoding table and the output character counters within the program.

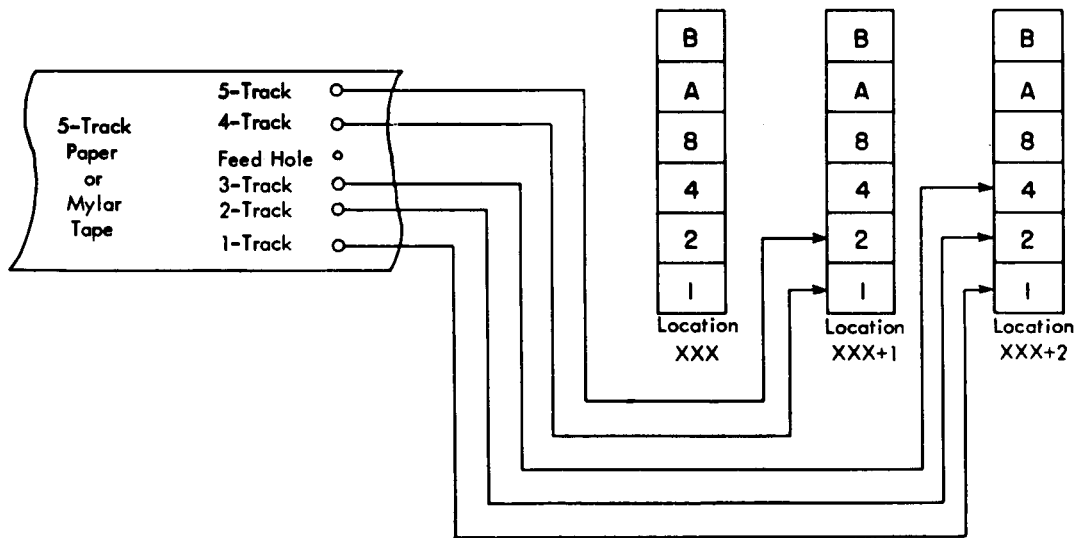


Figure 2. 5 Track Tape Punching to Relative Table Address Translation

Appendix D - Required Machine Configuration

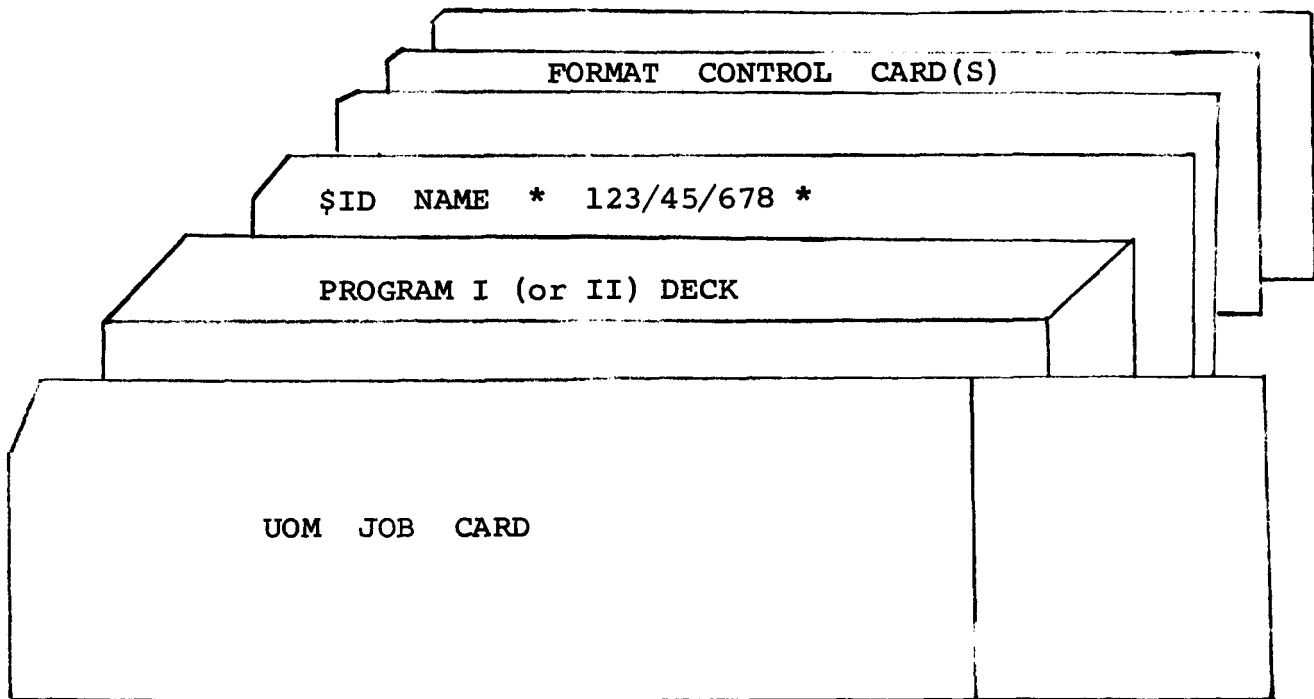
IBM 1011 Model 1 Paper Tape Reader or
IBM 1012 Model 1 Paper Tape Punch
IBM 729 Magnetic Tape Unit

IBM 1401 Model C3 Processing Unit with 8K storage

Special features:

Indexing
Multiply - divide
High - low - equal compare
Store address register instructions
Modify address instruction

Appendix E - Job Submittal Deck



Appendix F - Program Messages and Error Procedures

1. Initial instructions.

CHECK SENSE SWITCH SETTINGS

SWITCH A UP

SWITCH B UP FOR MAG. TAPE OUTPUT ON 1

SWITCH C UP FOR PUNCHED CARD OUTPUT

SWITCH D UP FOR PRINTED OUTPUT

SWITCH E UP FOR PARITY ERROR HALT

SWITCH F UP IF MORE THAN ONE(1) REEL OF PAPER TAPE WILL BE READ

SWITCH G UP FOR 80 COLUMN OUTPUT

PRESS START TO CONTINUE

2. Indication of reel termination or error condition to operator.

PAPER TAPE READER IS OUT OF READY.

PAPER TAPE PUNCH IS OUT OF READY.

3. Operator messages to load successive paper tape reels.

RELOAD AND READY READER (PUNCH) WITH ADDITIONAL PAPER TAPE REELS, IF ANY.

PUT SENSE SWITCH F DOWN IF THE LAST REEL HAS JUST BEEN COMPLETED.

PRESS START TO CONTINUE OR TERMINATE JOB.

4. Parity check error message printed when error occurs.

*** PARITY ERROR ENCOUNTERED IN READING THIS RECORD ***

5. Operator messages indicating magnetic tape handling procedures.

REDUNDANT MAGNETIC TAPE ERROR CANNOT BE IGNORED.

CHANGE TAPE AND/OR DRIVE.

REWIND AND LOAD PAPER TAPE INPUT.

PRESS START TO RESTART JOB.

MAG. TAPE IS FILLED.

MOUNT NEW TAPE ON UNIT 1.

INDICATE THE SEQUENCE OF OUTPUT TAPES ON THE TAPE SAVE CARDS.

0000000 RECORDS HAVE BEEN OUTPUT ON THIS TAPE.

6. Final accounting and termination messages.

0000000 PAPER TAPE RECORDS HAVE BEEN INPUT.

0000000 CARD IMAGE RECORDS HAVE BEEN OUTPUT.

SAVE TAPE ON UNIT 1.

JOB TERMINATED.

Error Procedures

To perform a high speed wind-up of the paper tape being read by the IBM 1011 Reader, program control may be transferred to location 7777 by the operator. To completely restart the job, the entire deck should be reloaded so that proper initialization will take place.

To recover from a program stop occurring when the EXT I/O light turns on and the end of reel on the IBM 1012 Punch has been reached, control may be transferred to location 7890 by the operator.

Appendix G - Summary of Available Programs

The following 1401 SPS source decks are available from the University of Maryland Computer Science Center, College Park, Maryland:

Program I - Version A

This program performs conversion of 5, 6, 7 or 8 channel paper tape records of constant length when the IBM 1011 is used as the input device.

Program I - Version B

This program performs conversion of 5 channel paper tape records of constant length when the IBM 1012 is used as the input device. It is provided with either the standard or blank decoding table.

Program I - Version C

This program performs conversion of 6, 7 or 8 channel paper tape records of constant length when the IBM 1012 is used as the input device. It is provided with either the standard or blank decoding table.

Program II - Version A

This program performs conversion of 5, 6, 7 or 8 channel paper tape records of varying length when the IBM 1011 is used as the input device.

Program II - Version B

This program performs conversion of 5 channel paper tape records of varying length when the IBM 1012 is used as the input device. It is provided with either the standard or blank decoding table.

Program II - Version C

This program performs conversion of 6, 7 or 8 channel paper tape records of varying length when the IBM 1012 is used as the input device. It is provided with either the standard or blank decoding table.

Bibliography of IBM Systems Reference Library Publications

IBM 1011 Paper Tape Reader, Form A26-5754-0

This manual contains information that describes the operating features, components, control panel, and tape handling and loading procedures for the IBM 1011.

IBM 1012 Tape Punch, Form A26-5776-0

This manual describes the operating features and components of the IBM 1012.

IBM 1401 Symbolic Programming Systems: SPS-1 and SPS-2,
Form C24-1480-0

This manual provides programmers with the information necessary to code a 1401 program in SPS language and assemble a machine-language object-program. It is assumed that the programmer has a basic knowledge of 1401 machine language programming.

System Operation Reference Manual, IBM 1401 (1460), Data
Processing System, Form A24-3067-0

This publication contains the instruction set for the IBM 1401. The operation code for every instruction is given in actual and mnemonic form, with examples of each.

Special Features, IBM 1401 (1460), Data Processing System,
Form A24-3071-1

The special features described in this system are available for the IBM 1401 and/or 1460 Data Processing Systems. Each feature is described and identified for the system to which it can be applied. These features offer additional flexibility in applications where special processing requirements exist.

Tape Input - Output Instructions, IBM 1401, 1440 and 1460,
Form A24-3069-2

This publication contains a description of the instructions used by the data processing system to operate the following tape units attached to it: IBM 729 Magnetic Tape Unit, IBM 1011 Paper Tape Reader, IBM 1012 Tape Punch.